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Hearing on
The National Security Implications of Climate Change

Before the
Permanent Select Committee on Intelligence
U.S. House of Representatives

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Chairman Schiff, Ranking Member Nunes, and distinguished members of the Committee, thank you for inviting me to speak with you today on the national security implications of climate change.

As a U.S. intelligence officer in the Department of State Bureau of Intelligence and Research it is my job to provide clear, objective, and independent analysis to policymakers to advance U.S. national security objectives. As a scientist in the intelligence community (IC), I blend insights derived from peer-reviewed journal articles and other scientific reports with information gathered from daily intelligence reporting to provide science-informed national security analysis. My understanding of this and other issues is deepened by the cadre of talented and dedicated officers in the IC, many with technical expertise, who quietly serve U.S. interests. This Committee is already aware that the IC does not advocate for any particular set of policies, including those that address climate change.

The Bottom Line

Fundamental characteristics of the global climate are moving outside the bounds experienced in modern history and there is uncertainty on how some aspects of the climate will evolve. Given the complex social and political contexts in which a multitude of changes are occurring, however, we can expect new and compounded stresses on people and societies around the world, many with outcomes important for national security.

Climate change will have wide-ranging implications for U.S. national security over the next 20 years through global perturbations, increased risk of political instability, heightened tensions between countries for resources, a growing number of climate-linked humanitarian crises, emergent geostrategic competitive domains, and adverse effects on militaries. Increasingly probable amalgamations of these security concerns are especially worrisome. Climate change alone is unlikely to trigger state failure in the next few decades but it will affect factors that that contribute to conflict, such as access to natural resources. People will increasingly decide to move because of deteriorating conditions, both within nations and into countries that are more prosperous. Perhaps most importantly, the rapidity of concurrent and compounded changes to Earth's systems, from human and natural causes, heightens the risk for unwelcome and possibly severe climate-linked surprises.

Framework for Analysis

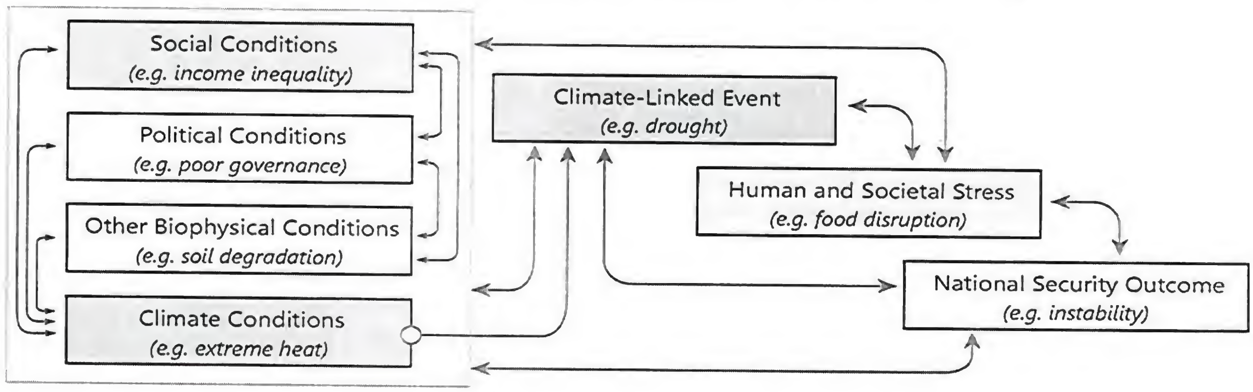
The IC's task with respect to climate change is to inform policymakers of the myriad risks and uncertainties that may lie ahead, rather than trying to predict the future. We have therefore examined a wide range of climate change effects, including those currently believed to have low probability, particularly if the ramifications could be highly impactful. The IC focuses on security considerations outside the United States, so we do not address the direct effects of climate change on the U.S. homeland. We expect, however, that many judgements could nonetheless apply to the United States.

For this analysis, we consider an event a national security concern when it:

- Produces a noticeable, even if temporary, degradation of one of the elements of U.S. national power: geopolitical, military, economic, informational, social cohesion
- Indirectly influences the United States, through a strategically important ally or partner
- Causes adverse effects that indirectly consume U.S. resources

Analyzing the national security implications of climate change generally requires tracing a logic trail from climate stressor to climate-linked event to societal stress to security concern, an endeavor complicated by climate conditions being intertwined in a complex of social, political, and biophysical conditions (Figure 1). Enumerating the large number of other important contributing factors is beyond the scope of this document, but illustrative examples include consumption patterns, demographics, environmental degradation, existing social and political conditions, land-use changes, emerging technologies, governance, and the tendency for populations to concentrate in climate-vulnerable locations. Changing climate conditions, in combination with other stressors, almost certainly will increasingly threaten national security over the next few decades.

Figure 1: Schematic Links Between Climate Change and National Security

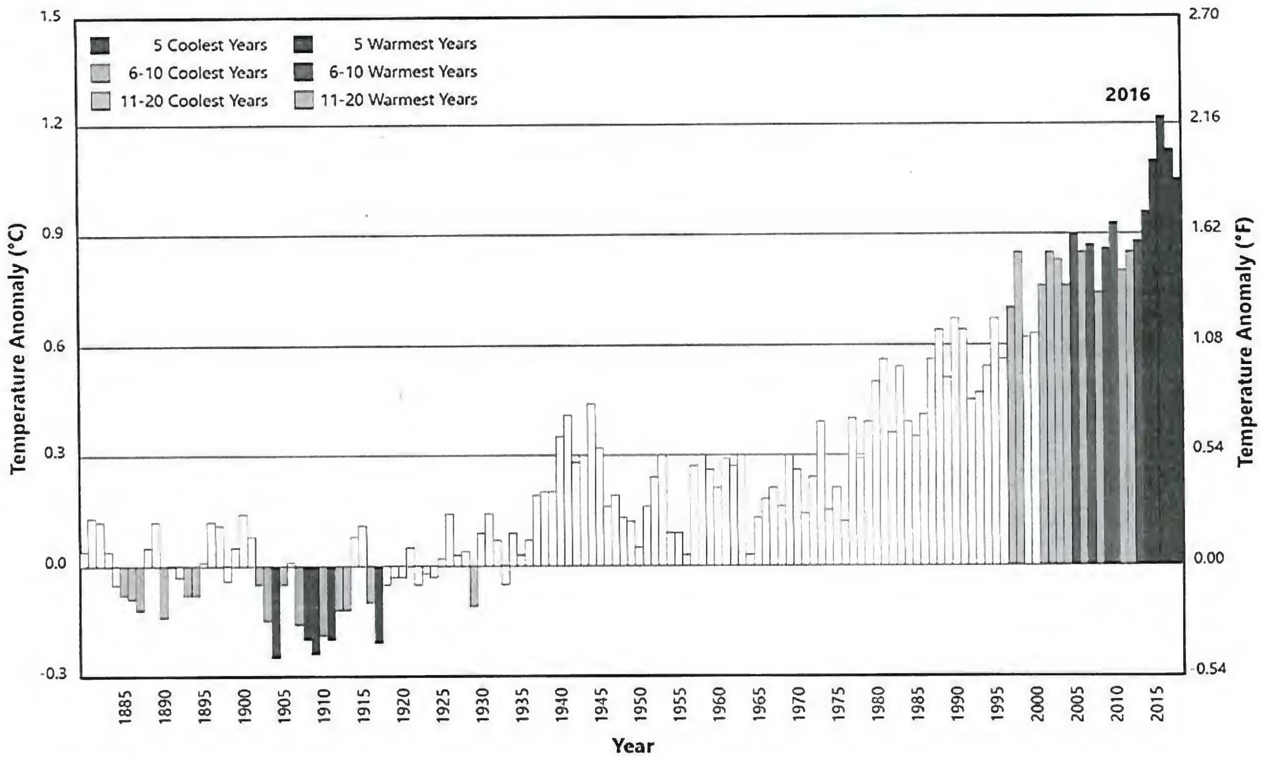


Source: Adapted from *Climate and Social Stress*, National Research Council 2013. Many links involve causal relationships in both directions, and some links are more important than others. Outcomes from human and societal stress are highly dependent on a given population's exposure, vulnerability to harm, and ability to cope, respond, or recover from a climate-linked event.

Scientific Baseline

The IC does not develop climate science; we instead rely on findings from outside sources. We prefer to use U.S. Government sources, such as NASA, NOAA, USGS, and the U.S. Global Change Research Program. In addition, U.S. scientific institutions such as the National Academies of Sciences, Engineering, and Medicine provide valuable consensus reports. We also utilize information and analysis from many other domestic and international sources, particularly the Intergovernmental Panel on Climate Change (IPCC) and peer-reviewed journals.

Figure 2: Global Temperature Anomaly by Year Since 1880



Source: NASA Goddard Institute for Space Studies Surface Temperature Analysis (GISTEMP v3) estimated values for land and ocean surface temperatures averaged globally. Temperature anomaly is the difference between a given year's temperature and a baseline computed by averaging temperature values from a sufficiently long time period, here using 1850-1899 data.

The Earth's climate is unequivocally undergoing a long-term warming trend as established by decades of scientific measurements from multiple, independent lines of evidence (Figure 2). Eighteen of the last 20 years have been the warmest on record and the last five years have been the warmest five, according to NASA's Goddard Institute for Space Studies, a finding echoed by other countries' meteorological agencies. Extreme high-temperature events are increasing across the globe as the distribution of observed temperatures skews towards higher values and the predictability of temperatures is declining. Temperatures are rising faster over landmasses, particularly near the poles, than open oceans, and global records indicated temperatures have been rising at all depths of the ocean, which absorbs over 90% of heat trapped within the Earth's climate. Ocean waters are also acidifying from the absorption of atmospheric carbon dioxide.

Looking ahead, global average surface temperatures will continue to increase over the next several decades, due largely to past emissions of long-lived greenhouse gases such as carbon dioxide. Beyond a few decades, however, additional temperature increases will critically depend on the cumulative atmospheric concentrations of greenhouse gases. Since ocean warming considerably lags that of the atmosphere, ocean temperatures will increase well into the future.

Rising temperatures in turn drive changes in a vast number of Earth system processes, particularly in the atmosphere, ocean, freshwater, soil, ice masses, permafrost, and organisms comprising the biosphere. The Earth's complexity complicates a detailed understanding of how these myriad temperature-dependent processes evolve and interact over time and space, but scientists have elucidated trends for an important set of climate-linked phenomena including and beyond temperature (Figure 3). Over time, ongoing temperature increases will likely expose populations to a greater number of concurrent climate-linked events. There will also be other unexpected—and potentially disruptive—climate-linked events currently uncharacterized by the scientific community.

Figure 3: IPCC-Projected Trends in Selected Climate-Linked Phenomena (2050-2100)

Phenomenon	Change	Confidence
Global mean surface temperature	⇧	HIGH
Global mean sea level	⇧	HIGH
Arctic sea ice cover	⬇	HIGH
Hot days and nights over land (warmth, frequency)	⇧	HIGH
Cold days and nights over land (warmth, frequency)	⬇	HIGH
Extreme high sea level (incidence, magnituide)	⇧	HIGH
Heatwaves and warm spells over land (frequency, duration)	⇧	HIGH
Heavy precipitation events	⇧	HIGH
Droughts (intensity, duration)	⇧	HIGH
Tropical cyclones in North Atlantic and Western North Pacific basins (intensity, frequency)	⇧	MEDIUM
Global mean precipitation	⇧	HIGH
Contrast between wet and dry regions	⇧	HIGH
Snow cover in the Northern Hemisphere	⬇	HIGH
Permafrost integrity	⬇	MEDIUM
Storm tracks (poleward shift)	⇧	HIGH
Wave heights in Arctic and Southern Oceans	⇧	HIGH
Upper ocean temperatures	⇧	HIGH
Ocean acidification	⇧	HIGH
Oceanic oxygen content	⬇	HIGH
Mountain phenomena (slope instability, mass movement, glacial lake outbursts)	⇧	HIGH
Animal and plant species distribution (poleward and upward in altitude)	⇧	HIGH
Timing of ecological spring events (leafing, greening, migration, etc.)	⇧	HIGH
Coral degradation and bleaching	⇧	HIGH

Source: Adapted from Intergovernmental Panel on Climate Change (IPCC), WG II, AR5, 2014. Projections assume that the average global temperature increase will exceed 2°C (3.6°F). The confidence statement reflects the IPCC's qualitative assessment of the robustness of evidence and agreement between different lines of evidence; "high" indicates very high or high confidence while "medium" denotes medium confidence. Phenomena with no clear trend or with significant regional variation are not shown. The IPCC employs the 2050-2100 timeframe to establish general trends; the national security window is usually shorter and on the order of days to a few decades.

Key

- ⇧ Increasing overall
- ⬇ Decreasing overall
- ⇧ More regions increasing than decreasing

Extreme weather and climate events are a major risk for all societies. They are caused by the rare occurrence of extreme values of certain meteorological variables, such as high and low temperatures (heat and cold waves), increased and reduced amounts of precipitation (floods and droughts), and high wind speeds (storms). Such events may occur at different rates, with different intensities, or at different locations compared to historical patterns, any of which may be disruptive. Over the last 10 years, the IC has deepened its appreciation of the significance of extreme weather events to national security. Most significantly, based on the science, we have come to appreciate that such events are a more near-term risk than previously assessed.

For classes of extreme events that increase in frequency of occurrence, we expect that the distribution of future extreme events in geographical location and time will be increasingly important in terms of potential for harm. Multiple extreme events of modest intensity that are clustered, compounded, or sequential may be more damaging or disruptive than single events that are more powerful. We also recognize the potential for analogous climate-linked extreme events in the biosphere, such as a mass die-off of an economically important species or sudden emergence of a destructive pest. Such events are not well characterized in the academic literature but are almost certainly important as an additional, and compounding, stress on societies.

High-impact, low-probability events are important when assessing risk from climate change because of their potential for substantial harm to people, Scientists are particularly interested in understanding climate-linked thresholds, beyond which large nonlinear shifts in subcomponents of the Earth's system occur. Although likely caused by intensive land-use, poor resource management policies, and naturally occuring drought rather than climate change, the 1930's Dust Bowl of the central United States nonetheless illustrates the severe social and economic impacts that can accompany unforeseen shifts in climate conditions. Since research has not sufficiently characterized many details of these climate-linked thresholds, including early warning indicators, crossing them is possible over any future timeframe. Potential future tipping point processes include:

- Very rapid die-offs of many critically important species, such as coral or insects
- Rapid conversion of Amazon and other rainforests to grassland
- Massive release of carbon from methane hydrates or permafrost carbon
- Discontinuous decrease in summertime Arctic sea ice
- Rapid melting in West Antarctic or Greenland ice masses
- Weakening of the regional North Atantic Ocean convection belt
- Increased strength of El Nino-Southern Oscillation
- Weakening of the Atlantic Meridional Overturning Circulation belt
- Changes in the West African Monsoon

Rapid-onset processes –particularly arising from socioeconomic or technological sectors—that offset or slow climate change effects, are also possible.

Stresses to Human and Societal Systems

Climate-linked events are disruptive to humans and societies when they harm people directly or substantially weaken the social, political, economic, environmental, or infrastructural systems that support people. For the next few decades, which represents the era of committed climate change irrespective of future greenhouse gas emissions, we expect that climate change will amplify existing stresses while also creating new ones for human and societal systems. Some stresses will be localized or limited to particular sectors, while others may have worldwide implications, such as disruptions to the global food supply (Figure 4).

Figure 4: Examples of Climate-Linked Stresses to Human and Societal Systems

Direct impacts from extreme events, such as droughts, floods, fires, and storms	Decreased surface water and groundwater resource supply and access	Reduced water quality from droughts or heavy rainfall
Increased species extinction and redistribution, and population reductions	Coastal impacts, such as flooding, submergence, surges, and erosion	Redistribution of catch potential for fish and invertebrates
Loss of marine biodiversity that support humans	Depressed crop yields and increases in yield variability	Risks to food access, utilization, storage, and price stability
Risks to global supply chains, such as food, minerals, and products	Shifts in production zones of food, fiber, and fuel crops	Decreased energy system integrity and reliability
Adverse effects on key economic sectors, such as insurance and tourism	Deterioration or loss of housing or shelter	Declining work productivity, especially from extreme heat
Decreased integrity and reliability of infrastructure	Disruption of ecological food webs	Increased displacement of people and changes in migration patterns
Negative repercussions on human health, including injury, disease, and death	Changing or emerging geographic domains, such as the thawing Arctic	Loss or degradation of resource-dependent livelihoods, such as agriculture and pastoralism
Loss of territory or infrastructure to sea level rise	Change in distribution of disease-carrying organisms	Increases in frequency, range, or toxicity of harmful algae

Though not exhaustive, this chart illustrates the multiplicity of potential stresses that could intensify or emerge from climate change.

Climate change will also produce benefical changes for some populations. For example, glacier melt could lessen water stress for perhaps a billion Asians over the next few decades, and most plants grow better under increased levels of carbon dioxide under optimal conditions. The balance of documented evidence to date suggests that net negative effects will overwhelm the positive benefits from climate change for most of the world, however.

National Security Implications of Climate Change

Climate change will affect U.S. national security interests over the next twenty years through multiple concurrent and compounded pathways. The following sections illustrate some significant national security concerns, but examples provided are illustrative rather than comprehensive.

Global Perturbations

No country will be immune to the effects of climate change over the next 20 years, but some will be able to cope, adapt, or respond more effectively than others. Most populations are likely to encounter multiple stresses across political, social, economic, and human security domains—fragile states in Sub-Saharan Africa, the Middle East, and Central and Southeast Asia are especially vulnerable. Local problems could spillover with global consequences, such as through increased human displacement, natural resource disputes, commodity price volatility, or violence.

Studies of potential economic costs from climate change vary considerably. Most estimates show limited aggregate damage to the global economy over the next 20 years, however economic damage to some nations or regions could be severe. Past and anticipated extreme climate events may discourage investments in regions deemed especially vulnerable, and insurance rates may rise well before actual adverse climate effects are felt. Progress on development, particularly in low-lying coastal areas, may stall or recede. A harsher climate also will stress or harm infrastructure not designed for such conditions, especially in urban settings. The financial burden of adapting and responding to emergent climate hazards and crises while expanding efforts to mitigate greenhouse gas emissions could reduce money available for other investments.

Threats to human health will emerge or intensify from climate change. Some groups of people are especially susceptible to climate-sensitive health hazards such as periods of extreme heat. Examples include young children and the elderly, populations experiencing social marginalization through poverty or migration status, and individuals already suffering adverse health conditions. Water-borne diseases such as diarrhea are highly sensitive to climate conditions. Long-term changes in climate could gradually shift the geographic range, seasonal timing, and transmission intensify of infectious diseases worldwide. Health care infrastructure and delivery systems are also likely to be affected.

Food security will almost certainly decrease in some regions. The precise impact of climate change on agriculture production will differ by region and crop, but damages are likely to be greater for countries located closer to the equator. Elevated overnight temperatures will put particular pressure on agricultural productivity. Fisheries productivity is likely to decrease in some areas, such as East Asia. Livestock will be increasingly vulnerable to periods of extreme heat and drought.

Climate change effects could undermine important international systems on which the United States and its partners are critically dependent, such as trade routes, food and energy supplies, the global economy, and domestic stability abroad. Poorly designed adaptation and mitigation responses to climate change could undermine long-term U.S. economic, energy, and security goals. Ongoing climate-related hazards, and the perception of Western responsibility, may engender hostility towards the United States or other industrialized countries.

Instability

Most, if not all, countries are unable to respond fully to the risks posed by climate-linked hazards under present conditions. With increased pressure from climate change, existing social and political structures will come under greater strain, which could deepen grievances and stoke tensions. Impacts would disproportionately fall on vulnerable populations, such as youth. The consequences likely will be severe enough in some instances to compel international reaction, including from the United States. Countries with weak institutions, low governmental legitimacy, or where the potential for conflict and political strife is already present, will have increased risk of instability. Cross-border displacement to neighboring poor countries may undermine regional stability.

Heightened Tensions over Natural Resources

Water. Decreases in water access, quality, or reliability may increase the risk of conflict between populations who share river basins or aquifers, especially at the subnational level. Although water is typically a source of cooperation between countries, extreme water scarcity or rapidly changing conditions could change this dynamic. Tensions are especially enflamed when an upstream country builds infrastructure, such as a dam, without a water-sharing agreement with downstream countries.

Fisheries. Disputes over fishing rights and access to fisheries have become major points of contention for countries that rely heavily on fishing for food or income. Ocean acidification and warming is likely to redistribute marine fish populations, benefitting some regions at the expense of others, while global fisheries face additional pressures from overexploitation and declining ocean health. Intensifying coral bleaching will harm reef ecosystems crucial for vast species of marine life.

Arable land. Declines in land resources crucial to livelihoods and sustenance are well-known drivers of local conflict. In some regions, climate change effects will worsen already degraded soil quality with concomitant effects on the people who depend acutely on its productivity.

Human Movement

An individual's decision to migrate depends on a variety of social and economic factors, and there is little evidence that climate change effects have been the determining factor in these decisions to date. Nonetheless, people are likely to perceive additional reasons to flee their homes because of

compounded climate change effects, primarily due to the loss of access to critical resources. In addition to movement within national borders—especially to urban areas—many displaced persons will migrate into neighboring countries, sometimes as a staging ground for subsequent onward movement towards countries with greater economic opportunities. Many receiving nations will have neither the resources nor interest to host these migrants. Increasingly inhospitable conditions and losses of territory from sea level rise will likely spur some island nations, particularly in the tropical Pacific, to consider relocating large segments of its population elsewhere. Over the next few decades, the net effects of climate change on patterns of migration and statelessness could be dramatic, perhaps unprecedented.

Humanitarian Crises

According to the World Bank, an estimated two billion people already live in fragile and conflict-affected areas of the world and, by 2030, at least half of the world's poor will live in these settings. These populations are at a disproportionately higher risk to climate-linked hazards. While natural disasters have happened for all of human history, extreme events amplified by climate change may pose newfound challenges, particularly when compounded events occur with greater frequency or severity in the same area. The exposure and resilience of people and assets of those affected are critical factors in how crises unfold. As humanitarian emergencies persist, the international community's capacity—or interest—to respond will be increasingly strained.

New Geostrategic Competitive Domains

The Arctic region is warming twice as fast as the rest of the globe and undergoing major and rapid transformation. Retreating sea ice creates new possibilities for resource extraction, tourism, and Arctic fishing, as well as new shipping routes between the Atlantic and Pacific, although operating in the Arctic will continue to prove difficult. Disputes over natural resource extraction operations or unresolved maritime limits and boundary claims will likely increase as the Arctic opens.

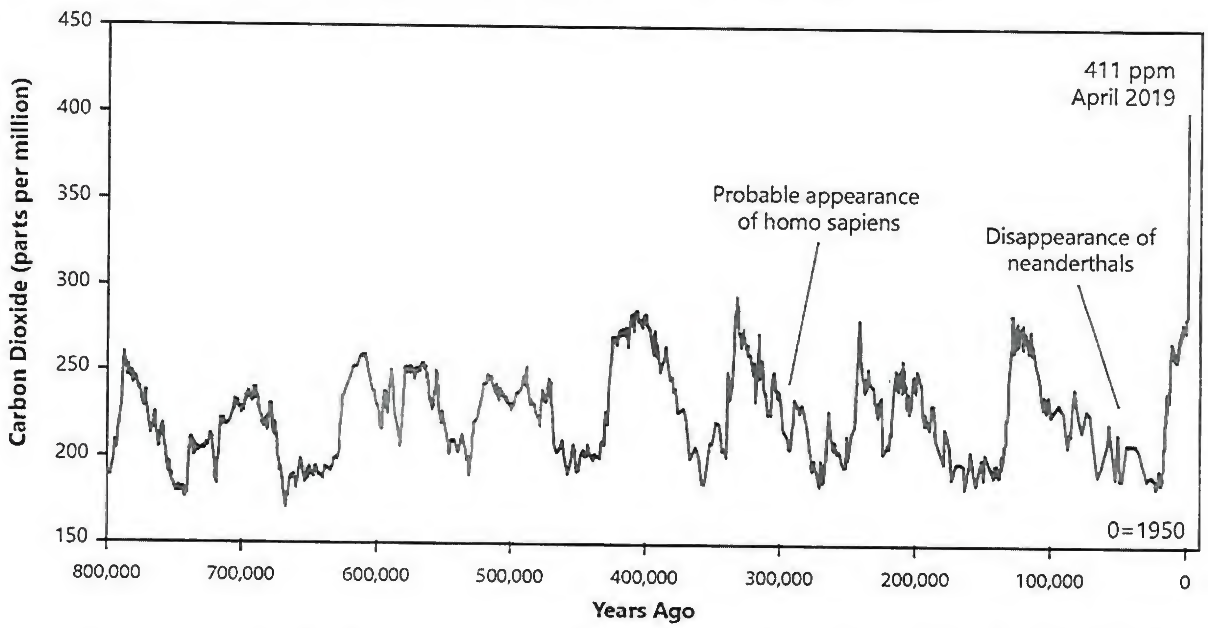
Adverse Effects on Militaries

Increasing sea-level rise, flooding, drought, temperatures, and extreme weather events will threaten military capabilities and facilities on domestic and foreign territory, including military bases and training ranges. Operations and equipment will also need to be able to withstand harsher weather conditions. Sea level rise and increased frequency of some tropical cyclones, and its associated impacts on erosion, will require significant levels of new surveying and mapping operations to ensure naval traversability and access to ports. Personnel may also be increasingly unprepared or trained for especially severe or novel conditions, such as fighting pests or combatting wildfires.

Heightened Risk of Climate-Linked Surprises

While climate models project continuous, long-term increases in temperature and other variables, scientists warn that sudden, dramatic climate shifts are possible, given the complexity of the system and analogs in the climate record. The Earth's climate occasionally has undergone extreme shifts that greatly challenge or overpower many species' ability to adapt, sometimes in as little as a decade or two. A large body of scientific evidence indicates that Earth's systems are being driven by natural and manmade forces at extraordinarily high rates of change across the atmosphere, biosphere, cryosphere, oceans, and soil. For example, the current rate of increase of atmospheric carbon dioxide is the highest in perhaps 66 million years and at levels not seen in at least 800,000 years (Figure 5).

Figure 5: Carbon Dioxide Levels from 800,000 Years Ago to Present



Source: National Oceanic and Atmospheric Administration (NOAA). Paleoclimate data are reconstructed from ice core samples while direct measurements have been collected since 1958 at the Mauna Loa Observatory, Hawaii.

Scientists are working out the precise degree to which the climate responds thermally to such pulses of carbon dioxide, but the resultant rate of temperature change is likely unprecedented in modern human history. Many scientists highlight the growing risk that abrupt impacts from climate change will increase over the next several decades and beyond. The national security implications of such changes could be severe.

Closing

The IC's role is not to predict the future but rather to assess risk and provide strategic warning. From a national security perspective, the disruption imparted by climate change and its associated effects over 20 years depends critically on at least four factors:

- The degree to which known levels of carbon dioxide and other greenhouse gases drive global and especially regional temperature increases: a large or small influence, or something in between

- The degree to which the multiplicity of concurrent or sequential climate-linked hazards interact, amplify, or offset each other

- The degree to which the drivers of climate change, particularly greenhouse gas emissions, will be addressed by people, governments, and industries

- The degree to which people's exposure and vulnerability to known and anticipated climate-linked hazards are reduced

The first two factors are scientific concerns and active areas of academic research; people's choices in the present and future, however, dictate the magnitude of the last two. The large range of uncertainties means that quantifying the appropriate timeframe for action is difficult—complicated by the fact that responses to stresses will often require many years to bear fruit. Absent extensive mitigating factors or events, we see few plausible future scenarios where significant—possibly catastrophic—harm does not arise from the compounded effects of climate change.

The State Department's Bureau of Intelligence and Research produced this document and did not coordinate with the rest of the intelligence community in its production.